CHAPTER 4

LOW-FLOW FREQUENCY ANALYSIS

4-1. Uses. Low-flow frequency analyses are used to evaluate the ability of a stream to meet specified flow requirements at a particular location. The analysis can provide an indication of the adequacy of the natural flow to meet a given demand with a stated probability of experiencing a shortage. Additional analyses can indicate the amount of storage that would be required to meet a given demand, again with a stated probability of being deficient. The design of hydroelectric power plants, determination of minimum flow requirements for water quality and/or fish and wildlife, and design of water storage projects can benefit from low-flow frequency analysis.

4-2. Interpretation.

a. Analytical frequency techniques are usually not applicable to low-flow data because most theoretical frequency distributions cannot satisfactorily fit the recorded data. It is recommended that graphical techniques be used and that known geologic and hydrologic conditions be kept in mind when developing the relationships. As the low values are the major interest, the data are arranged with the smallest value first. The probability scale is usually labeled "percent chance nonexceedance."

b. Annual low flows are usually computed for several durations (in days) with the flow rate expressed as the mean flow for the period. For example, the USGS WATSTORE output provides the mean flow values for daily durations of 1, 3, 7, 14, 30, 60, 90, 120 and 183 days. The default values for the HEC program STATS are the same with the exception of using a 15-day duration instead of 14 (Table 4-1). Often a climatic year from April 1 to March 31 is specified to provide a definite separation of the seasonal low-flow periods. Figure 4-1 is a plot of the data in Table 4-1.

4-3. Application Problems.

a. Basin Development. The effects of any basin developments on low flows are usually quite significant. For example, a relatively moderate diversion can be neglected when evaluating flood flow relations, but it would reduce, or even eliminate, low flows. Accordingly, one of the most important aspects of low flows concerns the evaluation of past and future effects of basin developments.

b. Multi-Year Events. In regions of water scarcity and where a high degree of development has been attained, projects that entail carryover of water for several years are often planned. In such projects it is desirable to analyze low-flow volume frequencies for periods ranging from 1-1/2 to 8-1/2 years or more. Because the number of independent low-flow periods of these lengths, in even the longest historical records, is very small and because the concept of multi- annual periods is somewhat inconsistent with the basic concept of an "annual event;" there is no truly satisfactory way for computing the percent chance nonexceedance for low-flow periods that are more than 1 year in length. One procedure described in reference (37) has been used with long sequences of synthetically generated streamflows to derive estimates of drought frequency. Although

Table 4-1. Low-Flow Volume-Duration Data.

- VOLUME-DURATION DATA - FISHKILL CR AT BEACON, NY - DAILY FLOWS

	LOWEST MEAN VALUE FOR DURATION, FLOW,CFS								
YEAR	1	3	7	15	30	60	90	120	183
1945	92.0	104.0	115.1	127.7	143.0	179.5	220.7	254.1	305.3
1946	9.4	12.8	17.6	21.3	28.5	49.8	62.1	58.7	75.4
1947	9.4	12.8	17.3	19.0	21.2	32.1	41.0	62.0	137.0
1948	8.3	10.2	15.7	15.7	18.9	21.6	27.4	33.5	78.1
1949	7.1	8.2	9.0	9.1	10.0	11.3	12.3	14.3	21.2
1950	22.0	22.0	23.9	27.0	32.6	37.0	43.1	51.1	119.0
1951	20.0	33.3	40.9	45.5	58.4	73.2	84.0	88.7	116.4
1952	34.0	39.7	43.0	44.0	46.2	64.6	100.1	97.9	135.3
1953	4.4	4.8	4.9	7.3	10.4	11.0	15.2	25.3	49.9
1954	8.4	9.5	12.3	14.6	16.7	22.9	39.8	99.8	160.8
1955	6.1	6.3	7.0	11.2	14.7	37.2	67.6	148.4	247.9
1956	19.0	21.3	23.0	26.8	29.5	53.5	59.5	71.3	98.2
1957	3.7	5.1	5.8	6.4	8.9	9.8	12.6	15.5	25.6
1958	12.0	13.3	17.4	19.2	23.8	29.6	41.5	50.9	118.5
1959	17.0	17.3	20.6	25.1	39.0	49.8	53.2	60.4	111.0
1960	48.0	48.3	53.3	63.9	77.5	122.1	136.3	149.1	213.9
1961	17.0	17.0	19.7	22.9	27.9	32.1	31.9	37.2	57.2
1962	5.9	6.6	7.0	7.8	9.9	15.0	16.7	20.6	41.9
1963	19.0	19.0	19.6	21.6	27.4	32.1	38.8	58.9	70.5
1964	1.1	1.4	1.8	2.5	4.2	7.1	9.0	11.5	19.1
1965	5.7	6.7	9.9	11.7	12.1	13.7	15.8	20.6	26.1
1966	4.0	4.5	4.7	4.8	5.0	6.4	13.2	21.8	64.8
1967	43.0	44.0	49.3	58.1	62.0	92.4	122.4	147.2	188.6

Note - Data based on Climatic Year of April 1 of given year through March 31 of next year.

the results obtained through the use of this procedure seem reasonable, it is impossible to verify the accuracy of the frequency estimates.

c. Regionalization. Regionalization of low-flow events is usually not very successful. The variations in geologic conditions such as depth to ground water, size of ground water basin, permeability of the aquifer, etc., are not easily quantifiable to enable translation into probable low-flow rates. It may be possible to estimate low-flow rates on a per unit area basis for a given exceedance frequency if the study area is relatively homogeneous with respect to geology, topography, and climate. If information is needed at several ungaged sites, the procedures described by Riggs (28) should be reviewed for applicability.

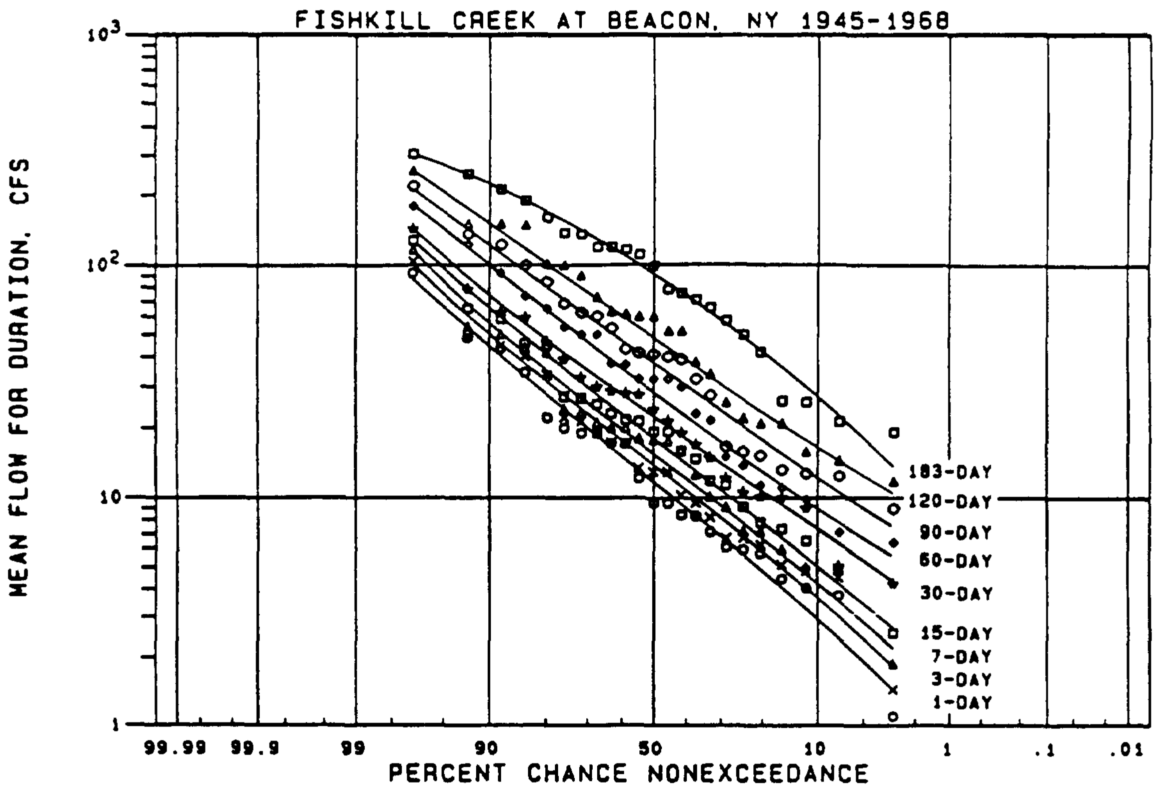

Figure 4-1. Low-Flow Frequency Curves.